

REASONS AND ACHIEVEMENTS OF THE MOBILITY AND PROFESSIONAL ACTIVITY OF PORTUGUESE ENGINEER CÂNDIDO CELESTINO XAVIER CORDEIRO (1842-1905)¹

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1.- Introduction.

Analysing the personal and professional career of an engineer enables us, through a specific case, to get closer to the society and economy of a given historical period and to address issues such as:

- i) the conditions of scientific and technical training in the country;
- ii) the training abroad and the contacts established between Portuguese engineers and other countries';
- iii) how these contacts, the stay abroad and the study visits helped the transfer of ideas and technologies;
- iv) the works that were being carried out in the country;
- v) the importance assumed by the development of the railways;
- vi) the different ways as men of science put their knowledge and experience at the service of the country's economic development;
- vii) the intervention of these technicians in political and administrative structures, either at central or local level.

These are some of the questions we will try to answer through the biography of Cândido Celestino Xavier Cordeiro, an engineer who worked in the second half of the 19th century and the first years of the 20th century, i.e., throughout an epoch that began with the Regeneration (1851-1868), a period of political stability and acceleration of material improvements in the country.

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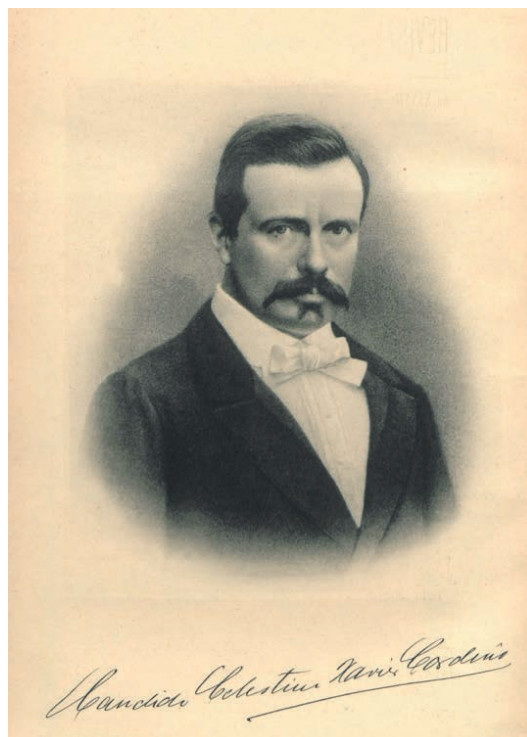


Fig. 1. - Photograph of engineer Cândido Celestino Xavier Cordeiro. Source: CARVALHO (1907).

To carry out this work, we have drawn on various sources such as newspaper articles and archive documentation, and on the various studies we have already done on this engineer, which have been based on the individual files held in both the former MOPCI archives and the Ecole de ponts et chaussées archives, on reports of his study trips and the news wrote about him.

To provide a better framework for the work carried out by Cândido Celestino Xavier Cordeiro, the article begins with a first point in which we try to contextualise the policy of public works and the development of transport, particularly railways, which began with the establishment of a new political regime, known as the Regeneration, and the creation of training institutions for Portuguese engineers.

1. 1.- The policy of developing public works and railways and the growing importance of engineers.

In 1851, the new political regime established in the country -The Regeneration²- elected the development of public works and the construction of a railway network as one of its priorities. To pursue this goal, the government carried out an administrative reorganisation and, in 1852, created the Ministério de Obras Públicas, Comércio e Industria (MOPCI) (Ministry of Public Works, Commerce and Industry), headed by an engineer, Fontes Pereira de Melo (1819-1887)³, who developed a policy of material improvements known as *Fontismo*. This statesman valued the technical skills needed to carry out major public works and to implement a railway network in the country. That's why engineers had significant representation in "their" ministry, mainly in the management of works and in the ministerial decision-making structure itself.

The members of this ministry's Conselho de Obras Públicas e Minas (Public Works and Mines Council), who were called to decide on the numerous works that were being planned or carried out, were also mostly engineers⁴. It was this Council that, on 17 January 1854, drew up the "General Communications Plan for the Kingdom", which envisaged the articulation between the various transport routes: railways, roads and rivers⁵.

However, as by the middle of the 19th century the number of engineers was still insufficient to respond to the policy of material improvements, the king (Pedro V), with the aim of mobilizing as many Portuguese engineers as possible for public works, published the Letter of Law of 7 August 1854 which allowed the government to employ army officers with a degree in engineering at any service under the MOPCI's Direção de Obras Públicas

2 The Regeneration was the name given to the Portuguese Constitutional Monarchy period which lasted from 1851 to 1868 and was characterized both by political stability and modernization of the country's infrastructures.

3 António Maria de Fontes Pereira de Melo, an important politician in the second half of the 19th century, trained at the Academia dos Guardas Marinas (Marine Guards Academy) and then at Escola do Exército

4 At the time, the board had the following members: Barão da Luz, José Feliciano da Silva Costa, and engineers Albino de Figueiredo Almeida, José Vitorino Damásio, João Crisóstomo de Abreu e Sousa, Francisco António Pereira da Costa and Joaquim Thomas Lobo d'Avila.

5 On the organization of Portuguese railways, see, among others, PINHEIRO (1986) and PINHEIRO; CARDOSO DE MATOS (2016).

(Directorate of Public Works)⁶.

That's why a large part of the country's public works was run by engineers with a military engineering background acquired at the *Escola do Exército*⁷ (Army School), created in 1836, which included a civil engineering course⁸. However, this training was not suited to face the challenges posed either by the construction of railway "works of art", the basic sanitation infrastructures or the new equipment required for urban modernisation. As engineer Joaquim Thomas Lobo d'Ávila (1819-1901) pointed out in a speech at the Chamber of Deputies in 1854, engineers "who are qualified with the knowledge of military engineering, do not, however, have all the necessary knowledge to direct public works", adding that, nevertheless, some of them "by their particular studies and their intelligence, provide useful services in the direction of public works"⁹.

On the other hand, the *Escola Politécnica de Lisboa* (Polytechnic School of Lisbon) and the *Academia Politécnica do Porto* (Polytechnic Academy of Porto), established in 1837 under the supervision of the Ministry of War, provided essentially theoretical training¹⁰. At the time of its creation, the Polytechnic School of Lisbon tried to follow the model of the *Ecole des ponts et chaussées* (EPC) (School of Bridges and Roads) in Paris, but failed to realise this project¹¹. The *Academia Politécnica do Porto* went even further, creating a five-year degree for "civil engineers of all classes, such as mining engineers, construction engineers, road and bridge engineers", but the number of engineers graduated by this school was scarce and, moreover, the theoretical teaching was not followed by practice in the field. As the engineer Silvério Augusto Pereira da Silva (1827-1910) said, contact with construction sites was essential and a lot of knowledge "can only be fully acquired at the sight of buildings"¹². The engineer Joaquim Thomas Lobo d'Ávila (1819- 1892), who

6 The time they spent in this ministry was counted towards their military career progression.

7 The *Escola do Exército* replaced the *Real Academia de Fortificação, Artilharia e Desenho* (Royal Academy of Fortification, Artillery and Design).

8 The two-year civil engineering course was organised around a set of subjects taught for military engineering. About this school, see MACEDO (2012).

9 *Diário da Câmara dos Deputados*, sessão de 10 July 1854,171-189.

10 On the training of engineers see DIOGO; CARDOSO DE MATOS (2007).

11 See CARDOSO DE MATOS (2013).

12 SILVA (1860: 229-230). At the time, this engineer was director of public works for the Aveiro district.

had attended the EPC in Paris, also emphasised the importance of training on construction sites, saying that “a student at the Ecole de Ponts et Chaussées of Paris, for example, studies for a certain period of time during the year in school and then goes into practice, and what happens is that the students leave the school in a state of ‘directing’ the works”¹³.

It was in this context that several engineers, after training at the Portuguese engineering schools, completed their training at engineering schools abroad, particularly at the EPC in Paris, which was by then an international benchmark¹⁴. They then returned to Portugal where they developed an important professional activity linked to public works and the railway.

Attendance of the EPC by students of various nationalities led to the creation of an *Espace transnational des “ponts et chaussées”* (Transnational Space of Bridges and Roads). This Transnational Space was defined by Konstantinos Chatzis, Dmitri Gouzévitch and Irina Gouzévitch as a movement of public works engineers from different countries across Europe aiming for “the gradual construction of a transnational space of practices, knowledge and institutions relating to the public works engineer, a space ‘common’ to several countries beyond the political borders that divided the European continent at that time”¹⁵.

Candido Xavier Cordeiro was an example of an engineer who, after his initial training in Portugal, completed his studies in Paris at the EPC and after his return to Portugal developed an important professional activity and became a reference in Portuguese engineering. He is also an example of the engineers belonging to this Transnational Space of the “ponts et chaussées”.

2.- The early years of Cândido Xavier Cordeiro’s life.

2.1.- Education and first professional experiences.

Cândido Celestino Xavier Cordeiro was born in Torres Novas in 1844. In 1851, his father was appointed pharmacist at the Leiria Hospital and, the following year, won the competition to become director of the Pharmaceutical

13 *Diário da Câmara dos Deputados*, sessão de 10 July 1854, 171- 189.

14 See GOUZÉVITCH; CARDOSO DE MATOS; MARTIKÁNOVÁ (2017).

15 CHATZIS; GOUZÉVITCH; GOUZÉVITCH (2009: 11).

Dispensatory at the University of Coimbra.

The family's stay in this academic city was advantageous for Cândido Xavier Cordeiro's education. In 1855, he enrolled in mathematics and philosophy courses at the University of Coimbra, finishing his studies in 1861. Given that, he decided to enrol at the Escola do Exército in Lisbon. In 1863, he graduated from this school with a degree in civil engineering, but, in the meantime, he also attended the Escola Politécnica de Lisboa, where he studied botany and political economy.

When the government created the Polytechnic School in Lisbon (in 1837), engineer Feliciano da Silva Costa (1798-1866) was commissioned to organize it. So, Silva Costa's choice, an engineer who had completed his training at the Parisian EPC, shows clearly the kind of teaching the Portuguese school sought to implement, taking that Parisian school as its model. With the same objective, in 1845 Albino Francisco de Figueiredo Almeida (1803-1858), a professor of the Polytechnic School, attended the EPC, also with the aim of updating his knowledge¹⁶. These engineers passed on to their students the knowledge acquired at the French school, as well as the new working methods and the importance of on-the-job training for engineers. During his stay at the Polytechnic, Cândido Xavier Cordeiro came into contact with these ideas, and this was probably one of the reasons why he applied for a scholarship to study at the EPC.

On 31 August 1863, shortly after getting his engineering diploma, he joined the MOPCI and was assigned to the Direção das Obras Publicas (Public Works Department) of the Castelo-Branco's district. By request of his father, he was eventually transferred to the Public Works Department of the Coimbra's district and, in March 1864, was appointed head of section. His appointment as "conductor"¹⁷ of public works instead of engineer led to a protest from Cândido Xavier Cordeiro, who had obtained his engineering diploma at the Escola do Exército. So, in April of that same year, he was promoted to engineer with a salary and gratuity of 2nd lieutenant¹⁸.

Among the different projects he carried out during those years, we may highlight the management of the road stretch from Condeixa to Penela, for

16 On this subject, see: CARDOSO DE MATOS (2013).

17 Conductor of public works was a post below the engineers.

18 AHME – Individual processo f Cândido Xavier Cordeiro.

which he was appointed in November 1863¹⁹.

2.2.- The studies at Ecole des ponts et chaussés in Paris.

In 1864, Candido Xavier applied for one of the scholarships offered by the Portuguese government to engineers wishing to complete their training at the EPC in Paris²⁰.

Although in the first half of the 19th century, several Portuguese engineers had accomplished their training at this school²¹, it was only from 1855 forward that the MOPCI began to select, through public competitions, the engineers who would study in Paris at the Ecole de mines (School of Mines) or at the EPC at the expense of the state²².

In the 1864 competition, Cândido Xavier Cordeiro came first, and engineers Augusto Luciano Simões de Carvalho (1838-1912) and João Veríssimo Mendes (Castanheirinho) were also selected.

The engineers who attended this school in the second half of the 19th century profited from the reform carried out in 1851, which adapted teaching to the new construction requirements posed by the development of railways and public works and led to several changes in the organisation and teaching at the school²³.

During his years at the EPC, Cândido Xavier Cordeiro benefited from the teaching of eminent professors such as Luis Charles Mary (1791-1870) at the rivers and canals course; Pierre Dominique Bazaine-Vasseur (1809-1893) at the railways course, Charles-François Hervé Mangon (1821-1888) at the agricultural hydraulics course; François Léonce Reynaud (1803-1880) at the architecture course and Romain Morandière (1809-1875) at the bridges course, a “proven engineer who left traces of his activity and expertise in the most difficult works of the Orléans line, namely the stretch between Tours

19 Letter from António Casimiro de Figueiredo, Acting Director of the Technical Department of Public Works in the District of Coimbra to the Director General of Public Works, dated 5 November. 1863.chaussées. AHME Individual process of Cândido Xavier Cordeiro.

20 There were 16 candidates in this competition, but Cândido Xavier Cordeiro came first.

21 Between 1825 and 1851, 19 engineers attended the EPC. On the subject see CARDOSO DE MATOS (2009).

22 By Article 30 of the Letter of Law of 17 July 1855.

23 PICON 1992, 611.

and Bordeaux”²⁴.

The notes compiled by Romain Morandière’s students in 1865 compose a volume from over 400 pages describing the various aspects of bridge construction, including tables, graphs and some drawings illustrating technique constructions.

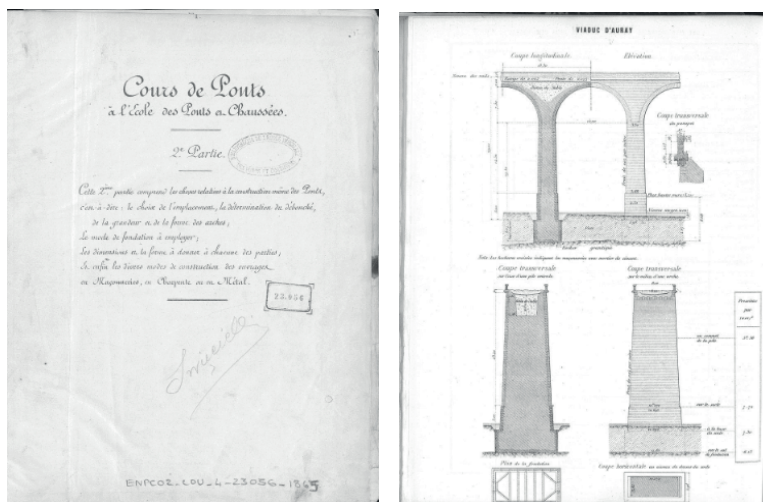


Fig. 2.- MORANDIERE, Romain (1865-1866) *Notes prises par les élèves au cours de ponts: 2ème partie*. Source: Héritage des ponts et chaussées, la bibliothèque numérique de l’Ecole des ponts - ParisTech.

During his years at the EPC, Xavier Cordeiro’s colleagues included, among others, the Frenchmen Alfred Picard (1844-1913)²⁵, “destined to be Picard the Great”, Antoine Guillain (1844-1915), who would become later Minister for the Colonies, and *Pierre-Louis- Edouard* Agnellet (1844-1900), the future chief engineer of the works in northern France. Between his foreign colleagues, there were personalities like the Polish Eustache Thomaz Skrochowski and Casimiri Zaleski.

From the beginning of his studies at the EPC, Xavier Cordeiro’s talent for calculation “caught the attention of his teachers and colleagues”²⁶. He also

24 AHME – Individual Process of Augusto Luciano Simões de Carvalho, page 544.

25 Alfredo Picard was a renowned French engineer and administrator who served as Vice-President of the Conseil d’État from 1912 to 1913. He was also the rapporteur for the 1900 Universal Exhibition in Paris.

26 CARVALHO (1907: 249).

distinguished himself by his levelling work and plans in the Vincennes forest, which surprised his teachers, and by the quality of his laboratory works, which “earned praise from Hervé Mangon”²⁷.

2.3.- Cândido Xavier's end-of-year missions during his three years at the EPC.

Theoretical training at the EPC was complemented by fieldwork and excursions carried out throughout the year. Among these expeditions, we can mention those that took place during Cândido Xavier Cordeiro's second year at the EPC: one to Bercy, to visit the general workshops of the Paris-Lyon-Mediterranean railway; other to Creil and Epone, to study geology and visiting, on the way, the famous forges of Montataire; and another to Auteil, to see the works of the belt railway and, above all, the construction site of the viaduct over the Point du Jour²⁸.



Fig. 3.- Viaduc du Point du Jour. Photographie de Hippolyte Auguste Collard. *Les Travaux Publics de la France*, Tome Premier : Routes et Ponts, Paris 1886. Source: Wikimedia Commons.

27 CARVALHO (1906: 544).

28 CARVALHO (1906: 547).

At the end of each year, the students had to go on a study mission, during which they had to visit and study the chief shipyards and construction sites in France. They had to draw up reports on their studies, which, in the case of the Portuguese students, also had to be submitted to MOPCI.

At the end of his first year's training, Cândido Xavier Cordeiro went on a study visit to Grenoble and its suburbs, as well as to the department of Isère. In this latter department, he visited the works to canalise the River Isère and its main tributaries as like those to drain the valleys. There he could see that the dykes by then built were sufficient to "free the crops from floods"²⁹. In Grenoble he visited the diverse works designed to ridding the city of the floods that regularly caused huge damages, as happened in 1859. He also visited the Grenoble bridge made up of three circular arches, being designed by the engineer Gentil and built in 1864. The following was a visit to the large reservoir built to harness the flood waters of the Paladru lake in the north of the city of Voiron, which, although it never dried up completely, recorded large fluctuations in its water reserves. That was why engineer Nestor Brisac (1836-1890) had realised a project to retain flood waters for use in summer. His tour ended with a visit to some roads of the departments of Isere and Savoy.

Cândido Xavier Cordeiro's second-year mission was to Marseille, a city he visited with his fellows Agnellet and Mendes Guerreiro to see, among other, the works of the harbour. During his third-year study mission, with his colleague Augusto Luciano Simões, both engineers travelled to the north of France, namely to Brittany to study the harbours.

29 CORDEIRO (1866: 46-59).



Fig. 4.- Viaduct of the Parfond du Gouët of the Chemins de Fer des Côtes-du-Nord 2010. Source: Wikipedia (Public domain).

During this study mission they could also see the Rennes and Nantes railways, remarkable for their beautiful masonry viaducts at Gouët, Morlaix and Châteaulin, and for their routes over hilly terrain very similar to those of our country.

3.- The travels of Cândido Xavier Cordeiro: An example of the mobility of engineers and the circulation of knowledge.

Throughout his life, Xavier Cordeiro often travelled, sometimes on behalf of the government and others on his own initiative, with the aim of studying engineering developments in various areas.

His interest in visiting major public works and shipyards, as well as his love for landscapes and getting to know the orography of the regions, meant that he was always one of the first to sign up for excursions organised by the Association of Portuguese Civil Engineers.

Nevertheless, he had travelled a lot for professional reasons, our engineer

was not “a traveller who, exclusively concerned with the object of his mission, was indifferent to anything else”. Therefore, he made a point of visiting monuments and museums, going to theatres and operas and had no “repulse by the atmosphere of cafés and restaurants”³⁰.

3.1.- Study visits to the Paris Universal Exhibition of 1867 and trips to London and Germany.

When the Universal Exhibitions have been held in Paris, the Portuguese government took advantage of this fact to commission national engineers, learning at the EPC, to study the progress of industries or transports, particularly railways, at these exhibitions. It was in this context that Cândido Celestino Xavier Cordeiro and Augusto Luciano Simões de Carvalho visited the 1867 exhibition³¹.

Cândido Xavier Cordeiro was commissioned to study, at the Paris 1867 Universal Exhibition, “the constructions and especially the lighthouses and the fixed and rolling stock of the railways”, a job he carried out with great skill. Due his interest in the railways, he “travelled and travelled again through the annexed sectors of the exhibition, visited the workshops of the great French companies, the stations where new types of material were being examined”³².

Since studying at the Exhibition was hard, as he couldn’t get all the explanations he needed from the exhibitors and the ones he did get were not trustworthy, he asked the Minister to grant him the time he needed to visit the material construction workshops and some new railways. In the meantime, he carried out his third-year study mission.

Having been granted permission to stay abroad for a few more months and having fulfilled his study mission as a third-year student at the EPC, Cândido Xavier had the opportunity to accompany engineer João Joaquim de Mattos to London, where he visited the city’s docks, the works of the new Westminster pier and of the Metropolitan Railway³³.

In April he left for Strasbourg in the companionship of engineer Mendes

30 CARVALHO (1906: 524).

31 CARDOSO DE MATOS (2004).

32 CARVALHO (1906: 550).

33 CORDEIRO (1866: 49).

Guerreiro with the purpose of visiting the Kehl bridge, a “monument of civil engineering”, and the Graffenstaden workshops, known “for the high quality of the materials used in their machines”³⁴. He then travelled to Mulhouse where, among other things, visited André Koeclini’s workshops, which he considered even more important than those in Graddenstaden. He travelled along the railway from Mulhouse to Wesserling and to Munich, where he saw some remote power transmissions via the Hirn cables and spoke to many engineers, including Von Dick, general manager of the state railways, who gave him a lot of information about the Bavarian railways. In Germany he also visited other places to find out more about the railways.

Subsequently he travelled to Milan where, through the Portuguese consul, Baron de Sousa Holstein, he met several engineers and visited the city’s general irrigation and cleaning system. From here he headed to Vienna, but stopped off in Venice, where he visited the maritime arsenal, and in Trieste, where he met a former EPC’s student, Ernest Pontzen (1838-1913), who attended the school between 1857 and 1860 and by then was in charge of the work being carried out in the port by the railway company. In Vienna he met another confrere of the EPC, Theodore Goldschmidt, who attended it between 1857 and 1860. Goldschmidt was then president of the EPC’s alumni association and eased his contacts and visits to countless workshops and works. He then travelled to Berlin, where he visited the buildings of the General Telegraph Directorate and the Borsig workshops, which were the most important workshops in the manufacture of locomotives. As Cândido Xavier Cordeiro said, “its locomotives are remarkable for the perfection of the labour and the relative lightness obtained by using steel and the best irons”³⁵.

The knowledge of railways that he acquired from this trip allowed him to write an important and detailed report published at the *Revista de Obras Públicas e Minas*, the journal of the Associação dos Engenheiros Civis Portugueses (Association of Portuguese Civil Engineers).

3.2.- The study trip to the 1878 Universal Exhibition and the Louvain Penitentiary.

By ministerial order of 29 July 1878, Cândido Xavier Cordeiro was appoin-

34 CORDEIRO (1870: 4).

35 CORDEIRO (1866: 7).

ted commissioner to the universal exhibition that took place that year in Paris. His duty was to study the current state of reduced-track railways abroad, but, since he had no information to help him to analyse this issue at the exhibition, "he was compelled to visit daily the galleries and annexes, visit stations and workshops, consult engineers and industrialists, attend tests and experiments, compare figures, circumstances and results"³⁶. In addition, he visited the secondary lines of the railway network in northern France, resulting all the knowledge then acquired in a *Memoria acerca dos caminhos de ferro de via* (Memoir on short-track railways) published in the *Revista de Obras Publicas e Minas* in 1879³⁷.

When still in Paris, he was commissioned to visit the Louvain penitentiary to see what kind of facilities would be suitable for the Lisbon penitentiary³⁸, and charged to buy the utensils and appliances needed to equip it³⁹. José Francisco da Costa Ramos, a machinist from the General Directorate of Geodesic Works, who was also in Paris on a study commission within the Universal Exhibition, was appointed to help him with this mission.

Following this appointment, Cândido Xavier Cordeiro travelled to Belgium and during this trip he could see, among other engineering works, the Antwerp harbour, which was in full swing under the direction of Abel Couvreur (1852-1922)⁴⁰, and Pierre Hildenert Hersent (1827-1903)⁴¹, and the railway from Anvers to Ghent, run by Baron de Prisse and his son.

However, according to the engineer Augusto Luciano de Carvalho who accompanied him, the trip was "useful and pleasant" and the "vocation of the engineer and the feeling of the artist were attracted at every step by objects of admiration". That is, at the same time they were visiting engineering works, they also visited the relic of St Ursula in Bruges and admired Van Eyck's

36 CARVALHO (1906: 562).

37 CARVALHO (1906: 563).

38 The Lisbon Penitentiary Project was drawn up by Joaquim Júlio Pereira de Carvalho, Luís Victor Le Cocq and Ricardo Júlio Ferraz. The first and third of these engineers had been students at the EPC. Ricardo Júlio Ferraz was also responsible for directing the construction of the penitentiary.

39 Order of 3 de September 1878.

40 The company A. Couvreur & H. Hersent contractors that also worked on the Ghent Maritime between 1874 and 1878.

41 Throughout his life, this engineer worked on various harbours and on the foundations of several bridges. As Dominique Barjot points out, "Fondateur d'une dynastie d'entrepreneurs, Hildebert Hersent épouse les valeurs de son temps » page 140. BARJOT (2003 : 133-159).

paintings, among other more cultural incursions⁴².

4.- His practice as an engineer (1868-1885): from managing railway works to working as an appraiser of built works.

In July 1868, Cândido Xavier Cordeiro returned to Portugal after his sojourn in the EPC and the trips he made afterwards on behalf of the government, topics we discussed in the previous section. After returning home, he resumed his position at the Public Works Department of the Coimbra's district, where he was supposed to report on his study mission.

A few months later, the Corpo de Engenheiros Civis (civil engineering corps) was abolish⁴³, while another decree of the same date created the District Public Works Departments to where Cândido Xavier Cordeiro was appointed, by decree of 13 January 1869, 1st Engineer of the Coimbra District Public Works Department.

The construction of the Minho railway line was decreed in 1872 but works extended until 1882, when the line reached Valença, i.e., they lasted for around a decade due largely to the complexity of a line built on rugged terrains. That was the main reason that led engineer João Joaquim de Mattos to request the contribution of three engineers graduated in Paris in 1867 -Cândido Xavier, Augusto Luciano Simões de Carvalho, and João Veríssimo Mendes Guerreiro- of whose competence he was aware since when "as an official commissioner, had been in Paris visiting the universal exhibition of that year"⁴⁴.

Cândido Xavier was responsible for the section between the right bank of the River Ave and the end of the Braga branch line. The know-how he showed in this section's works led him to "be award" with the 3rd section of the Tamel tunnel of Viana's railway line, where important "works of art" had to be built: the Tamel tunnel, underground with about one kilometer long; the Durrães Viaduct, 180 meters long and 22 meters high; and the bridge over the River Lima, built in 1878, with ten large 60 meters spans, "on whose pillars the compressed air foundation and large iron caissons were applied for the first

42 CARVALHO (1906: 563).

43 By decree of 30 October 1868.

44 CARVALHO (1906: 554).

time in our country, a system that begun to be used on the Kehl bridge"⁴⁵.

This engineer was familiar with the system used in the Kehl bridge, once he visited it in 1867 during a study visit to Strasbourg. It is worth clarifying that the construction of the bridge over the River Lima had been awarded to Eiffel, but once this one was already involved in the construction of the Oporto's Maria Pia bridge, decided to name Luiz Montagnier Guajarranque, who was already in charge of its foundations, to oversee the construction of that bridge.

The recognition of Cândido Xavier's mastery of engineering, mainly in the railway field, but also in those of the strength of materials and bridge construction, became clear when, in 1877, by order of 20 October, he was appointed, together with João Crisóstomo de Abreu e Sousa (1811-1895) and João Joaquim de Mattos, to the commission in charge to carry out the necessary tests to open to traffic the Maria Pia bridge. The task was difficult and entailed great responsibility, as they had to analyse a new type of bridge and a project led by engineers internationally recognised for their competence. Xavier Cordeiro, who was in charge of the test report, did it with great skill and concluded "with all firmness that the arrows observed were in accordance with the theories and that it could be no doubt about the solidity of the work"⁴⁶.

In 1879, by order of 28 July, he was appointed to the Advisory Board of Public Works and Mines. The 4th of the same month, another order appointed him member of the commission responsible for drawing up a project to reorganise the Ministry of Public Works and the technical services dependent on it. Shortly afterwards, he was appointed⁴⁷, together with Gilberto Rolla and João Joaquim de Mattos, to the commission charged to inspect district public works⁴⁸.

Later that year he was chosen, along with engineers João Joaquim de Mattos and Almeida d'Eça, to the commission carrying out the tests for the bridge that was supposed to cross the Tagus river in Santarém, also to be built by Gustave Eiffel, but he never took office on that commission because, in the meantime was appointed by the Ministry of the Navy and Overseas

45 CARVALHO (1906: 558).

46 CARVALHO (1906: 561).

47 By order of 13 September 1879.

48 The District Public Works had been created by decree on 30 October 1868.

Territories as government's representative in a contract intended to improve the Indian port of Mormugão and build a railway of Mormugão. signed with a group of British capitalists.

In India, Cândido Xavier Cordeiro met the engineer António Augusto de Aguiar, who at that time was the royal commissioner in English India, whom he already knew and whose friendship made it easier for him to integrate into the region. The instructions given to him were: to ensure that the best route for the railway was chosen; to also pay attention to the studies about the port of Mormugão; to gather all the statistical information in order to estimate the future traffic of the railway and the port; and to visit the railways, among others. At this Portuguese colony, he was supposed to work with Sawyer and, in fact, they did it so well that by August the field operations were over and Cândido Xavier Cordeiro could embark for London, where António Augusto de Aguiar was already and the contract with the Stafford House Committee was to be signed. Once this matter had been resolved, he returned to Lisbon⁴⁹.

In August 1880, just after returning from his trips to India and Britain, Cândido Xavier Cordeiro was appointed to the committee in charge of analysing the proposals submitted for the construction of the D. Luiz bridge (at Oporto) and choosing the most suitable one. He was chosen rapporteur of this commission, also made up of engineers João Joaquim de Mattos, who chaired it, Agnello José Moreira, João Anastacio de Carvalho and Augusto Luciano Simões de Carvalho.

The competition for the construction of this bridge was open by the Portuguese government in 1879. The work in question aimed to ensure communication between the two banks of the river Douro. Firstly, by a deck that must had an opening of at least 10,7 meters for river navigation and, secondly, by a road placed 60 meters above the river⁵⁰.

Several entrepreneurs linked to this branch of construction sent their proposals: the Société des Batignolles; Am Ende whose project would be carried out by Handyside et Cie, from Derby; Gustave Eiffel also presented a project involving an arch, similar to that of the Maria Pia bridge; the Cail & Cie; the Société de Willebroeck, sent two projects; the Société de Braine-le-Comte; the Schneider & Cie, from Le Creusot; the Compagnie de Fives-Lille; John Dixon;

49 CARVALHO (1906 : 571-572). On the Portuguese Indian railway, see PEREIRA; KERR (2019: 209-234).

50 *Mémoires de la Société des Ingénieurs Civils*, 4e série, 12e volume, janvier 1886, 39-40.

and Lecocq⁵¹.

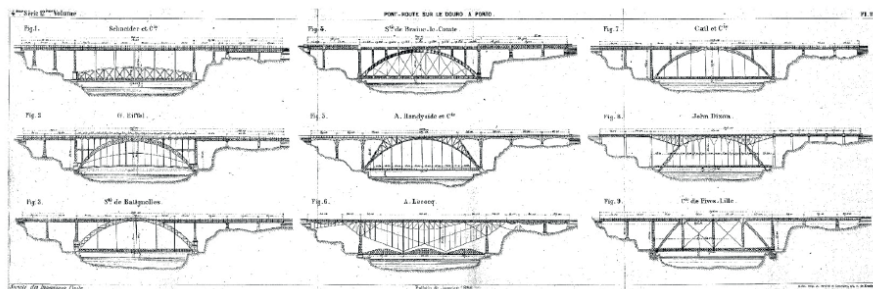


Fig. 5.- Projects presented by competitors for the bridge course. Source: *Mémoires et compte rendu des travaux de la Société des ingénieurs civils*, vol. 45, 1886, 1er semestre, p.111. (Conservatoire national des arts et métiers, Conservatoire numérique <http://cnum.cnam.fr>).

In addition to safety and the cost of construction, the commission should also consider the “aesthetic and artistic side [...] which is so often forgotten when it comes to using metal. The Commission did not fail to pay attention to this aspect, since the programme had announced in advance that the question of form would remain at the forefront of the discussion” and, according to Seyrig, “it can be said without any vanity [...] that the engineers of the French school were better inspired”⁵². After analysing the projects in detail, Xavier Cordeiro decided to award the construction of the bridge to Teófilo Seyrig. Once none of the other bidders submitted any complaints, the construction began in 1881 and lasted for five years (until 31 October 1886).

The exemplary way in which this competition was held contributed to the appointment of our biographed for head of the Public Works department, by decree of 17 March 1881. Shortly afterwards, however, with the approval of the railway and Mormugão port projects⁵³, he would be appointed⁵⁴ to represent the government at the conference with the Stafford House Committee that was to take place in London and where the technical aspects of the railway were to be defined.

51 On this subject, see CARDOSO DE MATOS (2020).

52 *Mémoires de la Société des Ingénieurs Civils*, 4e série, 12e volume, janvier 1886, 53.

53 Decree of 1 September 1881

54 Decree of 9 September 1881

Cândido Xavier Cordeiro received this mission without “enthusiasm and even tried to avoid it”⁵⁵, but finally gave in to the arguments presented to him. His technical skills were, in fact, decisive to make his point of view prevail towards the representatives of the English company, namely in getting that the railway works would be built on double track, as he had argued.

Shortly afterwards he was appointed director of public works in India, with the aim of organising the general plan for the roads, the railway and other projects. All the work he was entrusted with, he handled it “with equal solitude. A tireless walker, lively and light, wielding his classic walking stick, leaving at dawn and returning at night, he followed the same rules in the colony as in the metropolis”⁵⁶.

On 15 July 1885 Cândido Xavier Cordeiro was dismissed from his post in India and about a month later he asked for unpaid leave to join the Portuguese Railways Company.

5.- Labour at the Companhia Real dos Caminhos de Ferro Portugueses 1885-1902.

As mentioned, in 1885 Cândido Xavier Cordeiro started working for the Companhia Real dos Caminhos de Ferro Portugueses⁵⁷. During his stay at that company, Xavier Cordeiro worked on “projects of the greatest importance, both due to themselves as for the difficulties that arose during their execution”. Such was the case, for instance, of the bridges over the Mondego and Soure rivers; of the Oeiras viaduct; of the several viaducts and bridges on the Beira line, such as the bridge over the Tagus river in Abrantes; or of the S. Pedro viaduct, which at the time was the railway’s highest work.

Between 1886 and 1887, the government authorised the Companhia Real dos Caminhos de Ferro Portugueses to build the following facilities: a rail link between the East Line and the West Line; a double-track urban branch, connecting the West Line to an interface in the centre of Lisbon; and two branches of the future Belt Line. With the permission for the construction of these railway lines that aimed to connect the capital to the rest of the country,

55 CARVALHO (1906: 572).

56 CARVALHO (1906: 574).

57 SALGUEIRO (2008).

Lisbon was supposed to become the site of a major railway junction. Thus, the need to build a large station that could handle the heavier passenger and freight traffic expected from this kind of station.

Having decided that the station would be located in the city centre, such position obliged to the demolition of several buildings to create more space and to the opening of a tunnel under the city. In other words, it presupposed the construction of “a large underground track that would put the centre of the capital in direct communication with all the lines in the country and abroad”⁵⁸. Opened in 1889, this Central Station, known as Rossio Station, was built by the companies such as Baume & Merpent or the Duparchy & Bartissol, and Cândido Xavier Cordeiro supervised the construction assisted by the engineer Vasconcellos Porto.

Rossio station is an example of the transfer of technology by foreign companies working in Portugal, such as Baume & Merpent or the firm Duparchy & Bartissol. At the same time, the construction of this station also contributed to the affirmation of Portuguese engineering and architecture, thanks to the architects and engineers involved in its construction. When the station has been inaugurated on 8th April 1889, the *Gazeta dos Caminhos de Ferro* reported that “A great work of art has been inaugurated. It is both a daring feat of engineering and a beauty and convenience for our capital”⁵⁹.

As a representative of the company, Cândido Xavier took part in the International Railway Congress held in Paris during that year’s Universal Exhibition.

6.- His work as a business consultant and member of official commissions and his participation in congresses and periodicals (1885-1905).

Lisbon’s geographical location and the importance it could assume as a trading post justified the constant concerns about its harbour. In 1885, a group of merchants and capitalists, known as the Portuguese group, commissioned a committee of engineers to draw up a project to improve and increase the harbour, with the aim of competing in the tender that had been opened by then. This commission included a number of prominent engi-

58 MENDONÇA E COSTA (1889).

59 Idem.

neers like: Adolfo Ferreira Loureiro, Augusto Fuchini, Bento Fortunato de Moura Coutinho de Almeida d'Eça, Cândido Xavier Cordeiro, Frederico Ressano Garcia, João Joaquim de Mattos, José Joaquim de Paiva Cabral Couceiro e Manuel Afonso de Espergueira⁶⁰. The construction of the port of Lisbon involved the builder Pierre Hildevert Hersent, with whom Cândido Xavier Cordeiro had the chance to contact during his 1878 visit to the port of Antwerp, where Hersent was working at the time.

In the 1880s, when the Sociedade de Recreios Lisbonense (Lisbon Recreation Society) decided to build a new Coliseum in Lisbon where they wanted to install a large dome, they turned to Cândido Xavier for a technical opinion on the two projects that had been present to them: one from the Belgian company Nicaise & Deleuve in La Louvière and the other from Hein Lehmann & C. ^a in Berlin. The report presented by Cândido Xavier attested the superiority of the German project, and the dome installed on the building was imported from Germany.

The more systematic use of iron in the construction of bridges and viaducts on Portuguese railways and roads compelled the updating of the regulations that specified the rules these constructions had to follow and that dated back to 1863. By the end of the 19th century, this regulation was already “insufficient and obsolete on its precepts, because the ever-increasing demands of railway traffic and the necessary improvements that science and industry had introduced into the art of construction modified almost completely the structure of metal bridges”⁶¹. With this purpose, on 5 January 1895, was appointed a commission integrating renowned names of Portuguese engineering such as João Joaquim de Mattos, who had directed the construction of several railway lines; Bento Fortunato de Moura Coutinho d’Almeida d’Eça⁶²; António José Antunes Navarro and António Eduardo Villaça. Cândido Celestino Xavier Cordeiro and Pedro Ignacio Lopes, a former EPC member⁶³, were

60 On this subject, see MATA (2010).

61 Decree of 5 January 1895.

62 Among other activities, in 1873 this engineer carried out the first plans and estimates for the D. Luís bridge between Santarém and Almeirim, which was inaugurated in September 1881.

63 After graduating from the EPC, this engineer was seconded to work on studies and projects for the railway lines from Oporto and Coimbra to the Spanish border. In 1868, he replaced Manuel Afonso Espergueira as director of the Mondego and Barra da Figueira da Foz works and then joined the *Companhia Real dos Caminhos de Ferro*, where he was in charge of construction work on the northern line from Vila Real to Campanhã station in Porto. On this subject, see CARDOSO DE MATOS (2009).

also appointed to this commission, whose main task was drafting “the necessary instructions for the supervision, surveillance and conservation” of the country’s existing metal bridges and drawing up “the precepts, rules and conditions” to be fulfilled on the construction of metal bridges⁶⁴.

In 1896, Cândido Xavier Cordeiro was appointed as a member of a commission to study an accelerated road plan either the north of the Mondego river and the south of the Tagus river⁶⁵. In 1904, by order of 17 October, he joined the commission to study the establishment of a port in Buarcos (near Lisbon).

He also has been involved in several other commissions, because whenever a study required mastery of technical engineering knowledge his name was one of the first to come to mind.

Meanwhile, by decree of 20 May 1903, Xavier Cordeiro was appointed an effective member of the Superior Council of Public Works and Mines and by decree of 22 July inspector of public buildings.

In the last years of his life, he paid particular attention to the Vouga Valley railway, which he cherished “with almost filial love”⁶⁶.

As a founding member of the Association of Portuguese Civil Engineers, in 1895 he was elected its president and over the years was a regular contributor to the *Revista de Obras Públicas e Minas*, the Association’s official publication.

He was also a consultant for the *Gazeta dos Caminhos de Ferro de Portugal e Espanha*, where he published numerous articles. In 1901 he published the article “The Railways in the 19th Century” in which he said the following,

*“The 19th century can be called the century of wonders. One of the greatest is certainly the invention of the railway. The degree of perfection reached by these magnificent means of communication is the result of progress in chemistry, physics, mathematical analysis, metallurgy, the science of building stability, and also the progressive demand for greater comfort on the part of the interested public”*⁶⁷.

The sciences he was referring to were those he had developed through-

64 Decree of 5 de January 1895.

65 Decree of 6 October, 1896.

66 CARVALHO (1906: 585).

67 CORDEIRO (1901: 1).

hout his life to respond to the numerous missions he had been entrusted with and for which he had always been recognised.

7.- Conclusion.

The approach to the personal and professional career of engineer Cândido Xavier Cordeiro allowed us to realise how the conditions of training in the field of engineering were insufficient to acquire the technical skills that the development of public works and the railway required. That was why this engineer completed his training at the Ecole de ponts et chaussées (EPC) in Paris, a benchmark at the time. His sojourn at that school enabled him to learn about the latest advances in engineering and new construction techniques skills he acquired in the lectures of renowned professors, but also in the field through the various excursions and study missions he undertook during his years at the school.

Many of the engineers he met during his life may have been called to work in Portugal through his intermediary, such as Hersent, whom he had met on his study trips and who was later called to work on the Lisbon harbour. It is possible that the fact that Cândido Xavier Cordeiro had been a member of the Commission charged to study the harbour of Lisbon in 1885 favoured contacts with the French engineer.

The many study visits he made throughout his life, either to workshops of big companies, to “works of art” of the railway or to the universal exhibitions, to name but a few, allowed him to update his knowledge and to apply them, later, to works carried out in Portugal, becoming as so an agent of technology transfer.

Most of the projects in which he played an active role were railway projects. A man of his time, he had great admiration for this new means of transport. The layout and construction of the lines, especially in areas more difficult to access, were challenges he never shied away from. To find the best solutions for the railways in the country’s most rugged regions, he travelled to France and Germany, constantly reconnoitred the terrain and shut himself away in his office to make calculations and layout routes.

Throughout his life, he worked in the administrative structure of the state, but also in companies. Has been a consultant to the government and private individuals. Has appraised projects of the most renowned national and

foreign engineers and everyone recognised his technical competence and the probity of his decisions.

Cândido Celestino Xavier Cordeiro was, undoubtedly, an engineer whose life exemplifies the role these professionals played in the circulation of knowledge and the transfer of technology in the second half of the 19th century. Her mobility, i.e. her travelling for training and technical updating and her work in other regions made them an example of how assertive and integrated into the supranational space of the EPC the Portuguese engineers could be.

In fact, through their professional activity and their involvement in the political and social life of the country, the engineers who graduated from the EPC became an important factor in the affirmation of Portuguese engineering and a vehicle for the transfer of knowledge and technologies associated with civil engineering, which contributed to its modernisation.

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